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FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **208524US3PCT**

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR: #5

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/06518	**22 September 2000**	**27 September 1999**

TITLE OF INVENTION

BENDING APPARATUS FOR GLASS SHEET AND METHOD OF BENDING GLASS SHEET

APPLICANT(S) FOR DO/EO/US

Hiroshi YAMAKAWA, et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

PCT/IB/304 Notice of Priority
PCT/IB/308
Drawings (5 Sheets)
Request for Consideration of Documents Cited in the International Search Report

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
	PCT/JP00/06518	208524US3PCT

24. The following fees are submitted:.	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1000.00		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $860.00		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $710.00		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $690.00		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	22 - 20 =	2	x $18.00	**$36.00**	
Independent claims	2 - 3 =	0	x $80.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	

TOTAL OF ABOVE CALCULATIONS =	**$896.00**	
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.	**$0.00**	
SUBTOTAL =	**$896.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +	**$0.00**	
TOTAL NATIONAL FEE =	**$896.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐	**$0.00**	
TOTAL FEES ENCLOSED =	**$896.00**	
	Amount to be: refunded	$
	charged	$

a. ☒ A check in the amount of **$896.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.

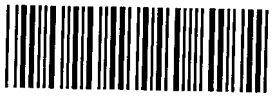
d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

TelephoneNumber: 703-413-3000
Fax Number: 703-413-2220

Surinder Sachar
Registration No. 34,423



22850

Surinder Sachar
SIGNATURE

C. Irvin McClelland
NAME

21,124
REGISTRATION NUMBER

May 9 2002
DATE

208524US3PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF: :

HIROSHI YAMAKAWA : ATTN: APPLICATION DIVISION

SERIAL NO: NEW U.S. PCT APPLN :
(Based on PCT /JP00/06518)

FILED: HEREWITH : EXAMINER:

FOR: BENDING APPARATUS FOR :
GLASS SHEET AND METHOD OF
BENDING GLASS SHEET

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to a first examination on the merits, please amend the above-identified application as follows:

IN THE CLAIMS

Please amend the claims as follows:

3. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.

4. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.

5. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

8. (Amended) The method of bending at least one glass sheet according to Claim 6, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace and disposed at a position opposed to the upper surface of the glass sheet to provide a predetermined temperature distribution on the glass sheet.

9. (Amended) The method of bending at least one glass sheet according to Claim 6, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

10. (Amended) The method of bending at least one glass sheet according to Claim 6, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

Please add new Claims 11-22 as follows:

11. (New) The bending apparatus for at least one glass sheet according to Claim 2, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.

12. (New) The bending apparatus for at least one glass sheet according to Claim 2, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.

13. (New) The bending apparatus for at least one glass sheet according to Claim 2, wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

14. (New) The method of bending at least one glass sheet according to Claim 7, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace and disposed at a position opposed to the upper surface of the glass sheet to provide a predetermined temperature distribution on the glass sheet.

15. (New) The method of bending at least one glass sheet according to Claim 7, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

16. (New) The method of bending at least one glass sheet according to Claim 7, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

17. (New) The bending apparatus for at least one glass sheet according to Claim 3, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.

18. (New) The bending apparatus for at least one glass sheet according to Claim 3, wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

19. (New) The method of bending at least one glass sheet according to Claim 8, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

20. (New) The method of bending at least one glass sheet according to Claim 8, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

21. (New) The bending apparatus for at least one glass sheet according to Claim 4, wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

22. (New) The method of bending at least one glass sheet according to Claim 9, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

IN THE ABSTRACT

Please replace the Abstract with the following amended Abstract:

ABSTRACT OF THE DISCLOSURE

A desired temperature distribution is efficiently formed on a glass sheet by a simple structure without lowering heat efficiency within a furnace. A heating furnace conveys a bending mold of a glass sheet and a radiation-heating device is provided in the heating furnace. A first group of a plurality of heating elements are fixed on an inner wall surface of the heating furnace. A second group of a plurality of heating elements are disposed separably from an inner wall surface of the heating furnace.

REMARKS

Favorable consideration of this application, as presently amended, is respectfully requested.

The present preliminary amendment is submitted to place the above-identified application in more proper format under United States practice. By the present preliminary amendment the claims have been amended to no longer recite any multiple dependencies. Subject matter of the cancelled multiple dependencies is also now presented in new Claims 11-22. The abstract has also been amended to be in more proper format under United States practice.

The present application is believed to be in condition for a full and thorough examination on the merits. An early and favorable consideration of the present application is hereby respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
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IN THE CLAIMS

Please amend the claims as follows:

--3. (Amended) The bending apparatus for at least one glass sheet according to Claim 1[or 2], wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.

4. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, [2 or 3,] wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.

5. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, [2, 3 or 4,] wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

8. (Amended) The method of bending at least one glass sheet according to Claim 6[or 7], wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace and disposed at a position opposed to the upper surface of the glass sheet to provide a predetermined temperature distribution on the glass sheet.

9. (Amended) The method of bending at least one glass sheet according to Claim 6, [7 or 8,] wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

10. (Amended) The method of bending at least one glass sheet according to Claim 6, [7, 8 or 9,] wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.--

Claims 11-22 (New).

IN THE ABSTRACT

ABSTRACT OF THE DISCLOSURE

A desired temperature distribution is efficiently formed on a glass sheet by a simple structure without lowering heat efficiency within a furnace. A heating furnace [15] conveys a bending mold [9] of a glass sheet and a radiation-heating device is provided in the heating furnace[, and a] . A first group of a plurality of heating elements are fixed on an inner wall surface of the heating furnace [15[, and a] . A second group of a plurality of heating elements are disposed separably from an inner wall surface of the heating furnace.

DESCRIPTION

BENDING APPARATUS FOR GLASS SHEET AND METHOD OF BENDING GLASS SHEET

TECHNICAL FIELD

The present invention relates to a bending apparatus for at least one glass sheet to bend a glass sheet into a desired shape at a high accuracy and a method of bending at least one glass sheet.

BACKGROUND ART

When bend-forming a window glass for an automobile, at least one glass sheet cut into a predetermined size and shape is placed on a ring-like bending mold, and is stayed in a plurality of heating sections for a predetermined time in a bending zone of a heating furnace, and is conveyed into the next heating section in order, and is heated to a bending temperature (usually about 550 to 650°C) of at least one glass sheet. Thus, the glass sheet is bended in accordance with the shape of the bending mold by self-weight.

In such a bending process of at least one glass sheet, it is necessary for obtaining a desired shape to accurately control a temperature distribution of the glass sheet at a high reproducibility. When at least one glass sheet is bended under a uniform temperature condition by placing on a ring-like bending mold, it is known that the central part of the glass sheet between frame parts at both ends of the bending mold sags and the

sectional shape of the central line of the glass sheet becomes a flat pan bottom shape at the sagged part, or becomes a shape, the central part of which is somewhat lifted. In order to make a shape of aimed design, it is necessary to maintain the peripheral zone of the glass sheet at a low temperature and the central part of the glass sheet at a high temperature, thereby forming a trapezoidal temperature distribution.

In a bending process of a glass sheet, it is known to form a temperature distribution on a glass sheet. For example, it is known to employ a method of placing a locally heating device faced to the side portions of a glass sheet in order to locally largely bend the side portions of the glass sheet. However, to locally heat the side portions of a glass sheet is a technical idea different from locally heating the central portion other than deformed portions in order to prevent deformation of the peripheral portion of the glass sheet.

On the other hand, there is known a glass molding apparatus provided with a heat-shielding plate to shield a bending mold for placing at least one glass sheet from heat in order to obtain such a temperature distribution as to make the temperature of the central part higher than the temperature on both ends of the glass sheet as mentioned above.

DISCLOSURE OF THE INVENTION

However, this conventional molding apparatus

provided with a heat-shielding plate is so complicated in respect of its structure as to disturb automatic conveyance of at least one glass sheet. Further, since the heat-shielding plate is fixed to a bending mold, a tensile stress is produced during cooling step in a zone of at least one glass sheet-placed portion of right above the heat-shielding plate, thereby lowering a strength of the glass sheet. Also, since the heat-shielding plate has a heat capacity which becomes a load to heating, it is hard to heat the whole within a furnace to such a high temperature as to be required for bending because heating energy is not efficiently used. As this result, a time required for bending is increased, and productivity is lowered.

In order to solve such a problem, JP-A-7-277754 proposes a method for obtaining a desired temperature distribution by providing a shield at appropriate position and height between heating elements, thereby limiting a heating range of the heating elements.

However, this method requires many shields to be provided depending on shapes of individual products, and is therefore hardly widely usable. Also, it is necessary to move many shields up and down respectively independently depending on the shapes of products, and it is therefore necessary to provide a plurality of elevating mechanisms which make the total structure very complicated. Also, in such a case, to provide shields

other than heating means makes an obstacle to raising the whole part within a furnace to a satisfactorily high temperature, and heating energy is not efficiently used, thus lowering heat efficiency.

The present invention has been made by taking the above conventional techniques into consideration, and an object of the present invention is to provide a bending apparatus of simple structure capable of efficiently forming at least one glass sheet into a desired shape at a high accuracy by forming a satisfactory temperature distribution on the glass sheet without lowering heat efficiency within a furnace.

In order to achieve the above object, the present invention provides a bending apparatus for bending at least one glass sheet placed on a bending mold into a desired shape by heating in a furnace, which comprises a bending mold for placing at least one glass sheet thereon, a tunnel-like heating furnace through which the bending mold is conveyed, a first group of a plurality of heating elements fixed on an inner wall of the heating furnace, and a radiation-heating device having a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.

Further, the present invention provides a method of bending at least one glass sheet into a desired shape, which comprises placing at least one glass sheet on a bending mold, introducing the glass sheet placed on the

bending mold into a heating furnace having a tunnel-shaped inside, and heating the glass sheet by two types of heating means of a first group of a plurality of heating elements fixed on an inner wall surface of the heating furnace and a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.

According to this structure, the whole part within the heating furnace can be maintained at a satisfactory heat-bending temperature by a first group of heating elements, and at least one glass sheet can be efficiently heated from a position closer to the glass sheet separated from the inner wall surface of the furnace by a second group of heating elements. Thus, by efficiently using each heating element, its heating energy can be used efficiently for bending the glass sheet without loss.

In this case, the first group of heating elements are fixed and supported at the ceiling side or floor side of the heating furnace by means of an appropriate mounting plate or supporting bracket or the like, and are thus firmly fixed on the inner wall surface of the furnace to provide a heating device. On the other hand, the second group of heating elements constitutes a separate heating device separated from the inner wall surface of the heating furnace.

A preferable structure example includes the second

group of heating elements which radiation-heat locally a predetermined position of at least one glass sheet to provide a predetermined temperature distribution on the glass sheet.

According to this structure, the whole part within a furnace is heated by the first group of heating elements, and at least one glass sheet is locally heated by means of the second group of heating elements placed at a position closer to the glass sheet than the first group of heating elements to form a required satisfactory temperature distribution on the glass sheet. By this manner, at least one glass sheet can be locally heated by efficiently using heat energy to provide a desired temperature distribution on the glass sheet.

The second group of heating elements are composed of a plurality of heating elements, each of which can control its heating temperature, and the second group of heating elements can be placed close to at least one glass sheet in such a manner as to form a desired temperature distribution on the glass sheet by radiation heat from each heating element (if the heating elements are placed too part from the glass sheet, the whole part of the glass sheet is uniformly heated and a satisfactory temperature distribution cannot be provided). By selectively using each heating element of the second group of heating elements, a heating temperature can be controlled and a desired temperature distribution can be

provided on the glass sheet. Also, by using the second group of a plurality of divided heating elements, it is possible to adjust a temperature depending on a size of a glass sheet employed, thus enabling a wide applicability.

A further preferable structure example includes the second group of heating elements suspended from the ceiling inner wall of the heating furnace in such a manner as to be opposed to the upper surface of at least one glass sheet.

According to this structure, it is possible to place the second group of heating elements close to the glass sheet by means of a simple structure without changing the structure of a bending mold and without adversely affecting the structure or movement of the conveying system.

Also, a further preferable structure example comprises the second group of heating elements placed at a variable distance from the inner wall surface of the heating furnace.

According to this structure, it is possible to vary a distance between at least one glass sheet and each heating element of the second group of heating elements. By this manner, it is possible to adjust a radiation-heat amount and to simply and accurately form a desired temperature distribution on the glass sheet by varying a position to be locally heated and a heating temperature depending on a material or shape of the glass sheet.

Also, a further preferable structure comprises the second group of heating elements, each of which has a heater wire and an equally heating plate provided on the heating surface of the heater wire.

According to this structure, it is possible to accurately control a temperature by equally imparting radiation-heat from each heating element to at least one glass sheet. Thus, the heater wire constituting a heating element is not exposed to at least one glass sheet but an equally heating plate is provided between the heater wire and the glass sheet. In this manner, a temperature is controlled by the surface temperature of the equally heating plate. By using the equally heating plate, an extreme local heating by the heater wire can be avoided, and a desired temperature distribution can be formed on the glass sheet without damaging the glass sheet.

Also, by using such an equally heating plate, each heating element can provide a uniform temperature face, and accordingly each heating element can be easily controlled by a computer and deformation analysis of at least one glass sheet can be easily made by means of finite element method, thus enabling to previously fix a temperature of each of individual heating elements.

As mentioned above, in order to achieve the above object, a radiation-heating device employed in the present invention comprises a first group of heating

elements fixed to an inner wall surface of a heating furnace and a second group of heating elements divided into each heating element in the vicinity of at least one glass sheet in the furnace, and a desired temperature distribution can be provided on at least one glass sheet by selectively employing each heating element or by adjusting its fixed temperature of each heating element. In such a case, the second group of heating elements for providing a temperature distribution are preferably individually divided and disposed along such a direction as to form a desired temperature distribution on at least one glass sheet. For example, when a heating device is prepared by arranging heating elements of longitudinal shape in a row and the heating device thus prepared is applied to preparation of a window glass for an automobile, heating elements are disposed so as to put the longitudinal direction of each heating element along the direction vertical to the center line of at least one glass sheet (width direction of a glass sheet) in the vicinity of the central part of the glass sheet. Also, in the central part of the side periphery, in order to control a bending depth of at least one glass sheet, the heating elements are disposed so as to put the longitudinal direction of each heating element in the direction parallel to the centerline of at least one glass sheet (see the following Figure 4).

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a general structure view illustrating a bending apparatus for at least one glass sheet employed in the present invention.

Figure 2 is a structure view illustrating an example of a radiation-heating device used in the present invention.

Figure 3 is a structure view illustrating another example of a radiation-heating device used in the present invention.

Figure 4 is a structure view illustrating still another example of a radiation-heating device used in the present invention.

Figure 5 is a sectional view illustrating an example of a radiation-heating device used in the present invention.

Figure 6 is a sectional view illustrating another example of a radiation-heating device used in the present invention.

Figure 7 is a structure view of the inside of a furnace illustrating an example of a bending apparatus of the present invention.

Figure 8 is a structure view of the inside of a furnace illustrating another example of a bending apparatus of the present invention.

Figure 9 is a sectional view illustrating a preferable structure of a heating element used in the

present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, the embodiments of the present invention are explained with reference to the drawings.

Figure 1 is a general structure view illustrating a bending apparatus for at least one glass sheet concerning an embodiment of the present invention.

A tunnel-like heating furnace 1 comprises a preheating zone Z1, a bending zone Z2 and a annealing zone Z3. Each zone comprises a plurality of sections (in this example, the preheating zone comprises 4 sections, the bending zone comprises 8 sections and the annealing zone comprises 4 sections). A conveyer (not shown) is provided through the preheating zone Z1, the bending zone Z2 and the annealing zone Z3, and a bending mold (not shown) having at least one glass sheet placed thereon is conveyed through a heating furnace by the conveyer. In the bending zone Z2, a ceiling heater (not shown), a floor heater 3 and a side wall heater (not shown) are provided respectively on the ceiling, floor and side wall of the heating furnace 1. Each of the ceiling heater, the floor heater and the side wall heater comprises a plurality of heating elements fixed on an inner wall surface of the heating furnace 1 by an appropriate fixing and supporting means. These ceiling heater, floor heater and side wall heater heat the whole part within a furnace, and constitute a first group of heating elements

of the present invention.

A divided radiation-heating device 2 of the present invention is provided on the upper side of a conveyer (not shown) of each section of the bending zone Z2 in such a manner as to be separated from the ceiling inner wall of the heating furnace. The radiation-heating device 2 constitutes a second group of heating elements of the present invention.

The bending mold comprises a ring having a shape curved so as to almost corresponds to an aimed bending shape of the periphery of at least one glass sheet as the main constituting element.

After cutting a glass sheet into a predetermined shape, one or two or more glass sheet is placed on the bending mold and heated to about 500°C in the preheating zone Z1. Thereafter, the glass sheet is heated so as to form a desired temperature distribution thereon in the bending zone Z2, and is bended into a shape in conformity with the shape of the bending mold by self-weight. The glass sheet is then slowly cooled in the annealing zone Z3.

The bending mold having the glass sheet placed thereon is conveyed so as to intermittently stop at each section in the heating furnace 1. A desired temperature distribution is formed on at least one glass sheet by the radiation-heating device (second group of heating elements) of the present invention while staying in a

section in order in the bending zone Z2 in the furnace. The temperature distribution becomes an aimed temperature distribution when the bending mold is stayed in the final section of the bending zone Z2, and the glass sheet is bended into a desired shape by self-weight.

Figure 2 is a structure view illustrating an example of a radiation-heating device 2 (second group of heating element) provided in the heating furnace of Figure 1.

A plurality of heating elements of longitudinal shape (nine elements in this example) ① to ⑨ are disposed in a row to form a radiation-heating device 2. Each of the heating elements ① to ⑨ is disposed in the left and right direction of the central part of the glass sheet 4 or 5 of forming a window glass for an automobile in such a manner as to put the longitudinal direction of each element in the vertical direction (horizontal direction) of the center line C of the glass sheet 4 or 5. By this manner, a temperature distribution is formed depending on a radiation heat from each heating element along the center line C of the glass sheet 4 or 5. The radiation-heating device 2 is provided in the vicinity of the upper side of the glass sheet in the bending zone Z2 of the heating furnace 1. The floor heater 3 is provided on the lower side of the glass sheet. The floor heater 3 also comprises a plurality of divided heating elements in the same manner as in the radiation-heating device 2 provided on the upper side of the glass sheet, and this

is preferable for forming a temperature distribution at a higher accuracy. In this case, a distance between the glass sheet and the radiation-heating device 2 is adjusted so as to be capable of forming an aimed temperature distribution by each heating element, and is in the range of about 50 to 250 mm. A surface temperature of each heating element of the radiation-heating device 2 is controlled individually depending on each heating element in each section.

A bending mold having at least one glass sheet placed thereon can be accurately stayed at a predetermined position of each section in the furnace. The deepest position of the section of a glass sheet to be bended is determined by a position relationship between a radiation-heating device 2 and a glass sheet 4 or 5. When a windshield glass of an automobile is designed so as to be smoothly connected with a roof part, the most deeply bended position of the section of the windshield glass is on the upper part (upper part of the windshield glass mounted on a car body). In the case of such at least one glass sheet, a temperature distribution having a higher temperature at the upper part of the glass sheet can be easily formed by adjusting a position of stopping the bending mold having the glass sheet placed thereon and a temperature of each heating element depending on disposition of the radiation-heating device 2 shown in Figure 2.

Figure 3 is a structure view illustrating another embodiment of a radiation-heating device 2 of the present invention.

This embodiment comprises a radiation-heating device 2 having five heating elements ① to ⑤ placed along the center line C in the central part of the inner side of a glass sheet 6.

Figure 4 is a structure view illustrating still another embodiment of a radiation-heating device of the present invention.

This embodiment comprises two heating elements a and b and two heating elements c and d respectively provided on the left side and the right side of heating elements ① to ⑨ in the central part in addition to the radiation-heating device illustrated in the above Figure 2 in order to form a temperature distribution on both side parts in the left and right direction (width (car width) direction of a window glass for an automobile) of a glass sheet 6.

Figure 5 is a sectional view illustrating an example of a radiation-heating device 2.

In this example, each of heating elements ① to ⑨ is provided on a heater rack 7 in such a manner as to make the height of the lower side face (heat-radiating face) of each heating element constant. The heater rack 7 is supported separably from the ceiling inner wall of a heating furnace.

Figure 6 is a sectional view illustrating an

embodiment wherein the disposition of each of the heating elements ① to ⑨ of the radiation-heating device 2 shown in Figure 5 is changed.

In this example, a height of each of heating elements ① to ⑨ on the heater rack 7 is made variable, and each height of each heating element is variable as compared with the embodiment illustrated in Figure 5. By adjusting the height of each heating element depending on an aimed temperature distribution to be formed on at least one glass sheet, the aimed temperature distribution can be more accurately formed. By adjusting the height of each heating element depending on an aimed shape of at least one glass sheet to be bended, a desired temperature distribution can be formed on at least one glass sheet having various shapes. Also in this example, the heater rack 7 is supported separably from the ceiling inner wall of the heating furnace in the same manner as in the example of Figure 5.

Figure 7 is a structure view of an inner part of a furnace illustrating an example of a bending apparatus of the present invention.

As shown in this Figure, a ceiling heater 8 is provided on the ceiling of a heating furnace 15 (bending zone Z2 in Figure 1). Also, a conveyer 10 is provided through each zone Z1, Z2 and Z3 in the heating furnace (see Figure 1), and a bending mold 9 is conveyed. At least one glass sheet (not shown) is placed on the

bending mold 9. A floor heater 3 is provided under the conveyer 10. In this manner, a first group of heating elements comprises the ceiling heater 8 and the floor heater 3. A radiation-heating device 2 (a second group of heating elements) is suspended in the vicinity above at least one glass sheet (not shown) on the bending mold 9. In this case, the ceiling heater 8 on the back side of the radiation-heating device 2 may be selectively used without using all of them.

Figure 8 is a structure view of an inner part of a furnace illustrating another example of a bending apparatus of the present invention. In this example, a radiation-heating device 2 comprising heating elements ① to ⑤ having various heights provided on a heater rack 7 is suspended from the ceiling of a furnace as a radiation-heating device in the same manner as in the example of Figure 6.

Figure 9 is a sectional view illustrating a preferable structure of a heating element.

A ceramic board 13 is provided on the lower side of a heater rack 7, and a heater wire 14 is embedded within the ceramic board 13. An equally heating plate 11 is fixed on the heater rack 7 by a supporting rod 12 so as to cover the lower side of the heater wire 14. By providing the equally heating plate 11, heat from the heater wire 14 makes a temperature within the equally heating plate equal, and a uniform radiation heat from

each heating element can be applied to at least one glass sheet, thereby enabling to control a temperature distribution at a high accuracy. In place of using such an equally heating plate 11, a heating element having a temperature-controlling heating face may be used to control a temperature of the heating surface.

INDUSTRIAL APPLICABILITY

As explained above, according to the present invention, at least one glass sheet can be satisfactorily bended by effectively using each heating element, i.e. by maintaining a satisfactory heat-bending temperature in the whole part in a heating furnace by a first group of heating elements fixed on an inner wall surface of the heating furnace and by efficiently heating the glass sheet by a second group of heating elements provided at a position close to the glass sheet but apart from the inner wall surface of the furnace.

Also, it is possible to efficiently form a desired temperature distribution on at least one glass sheet at a high accuracy by a simple structure having a heating device comprising a plurality of temperature-controlling heating elements provided close to the glass sheet so as to be capable of forming a temperature distribution on the glass sheet by radiation heat from each heating element. By this manner, a glass sheet to be bended can be efficiently heated in conformity with its shape, and the accuracy of bending can be raised and productivity

can be improved.

CLAIMS

1. A bending apparatus for bending at least one glass sheet placed on a bending mold into a desired shape by heating in a furnace, which comprises a bending mold for placing at least one glass sheet thereon, a tunnel-like heating furnace through which the bending mold is conveyed, a first group of a plurality of heating elements fixed on an inner wall of the heating furnace, and a radiation-heating device having a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.

2. The bending apparatus for at least one glass sheet according to Claim 1, wherein the second group of heating elements radiation-heat locally at least one glass sheet at a predetermined position to provide a predetermined temperature distribution on the glass sheet.

3. The bending apparatus for at least one glass sheet according to Claim 1 or 2, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.

4. The bending apparatus for at least one glass sheet according to Claim 1, 2 or 3, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.

5. The bending apparatus for at least one glass sheet according to Claim 1, 2, 3 or 4, wherein each heating

element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

6. A method of bending at least one glass sheet into a desired shape, which comprises placing at least one glass sheet on a bending mold, introducing the glass sheet placed on the bending mold into a heating furnace having a tunnel-shaped inside, and heating the glass sheet by two types of heating means of a first group of a plurality of heating elements fixed on an inner wall surface of the heating furnace and a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.

7. The method of bending at least one glass sheet according to Claim 6, wherein the second group of heating elements radiation-heat locally at least one glass sheet to provide a predetermined temperature distribution on the glass sheet.

8. The method of bending at least one glass sheet according to Claim 6 or 7, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace and disposed at a position opposed to the upper surface of the glass sheet to provide a predetermined temperature distribution on the glass sheet.

9. The method of bending at least one glass sheet according to Claim 6, 7 or 8, wherein a distance between

the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

10. The method of bending at least one glass sheet according to Claim 6, 7, 8 or 9, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

ABSTRACT

A desired temperature distribution is efficiently formed on a glass sheet by a simple structure without lowering heat efficiency within a furnace.

A heating furnace 15 conveys a bending mold 9 of a glass sheet and a radiation-heating device is provided in the heating furnace, and a first group of a plurality of heating elements are fixed on an inner wall surface of the heating furnace 15, and a second group of a plurality of heating elements are disposed separably from an inner wall surface of the heating furnace.

FIG. 1

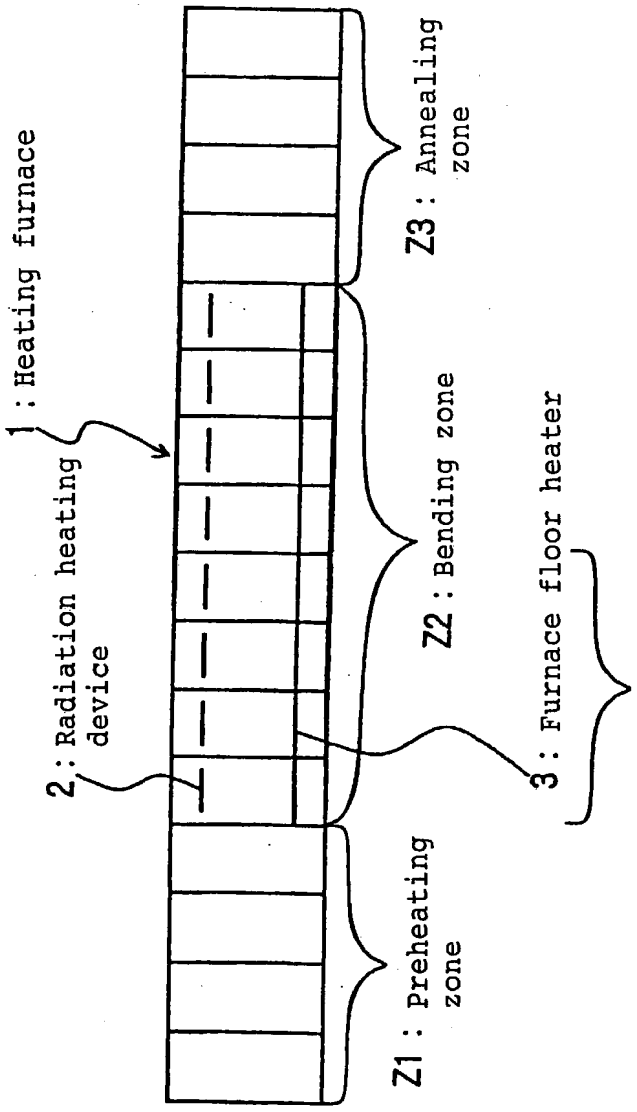


FIG. 2

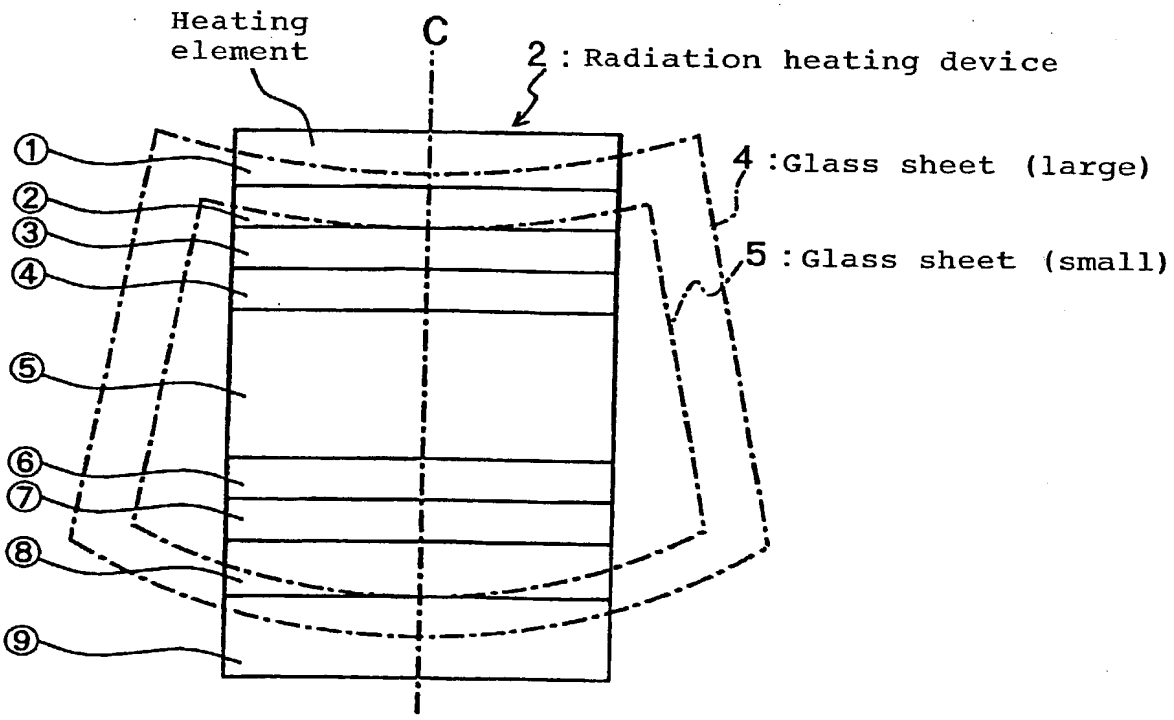

Heating element
C
2 : Radiation heating device
4 : Glass sheet (large)
5 : Glass sheet (small)
①
②
③
④
⑤
⑥
⑦
⑧
⑨

FIG. 3

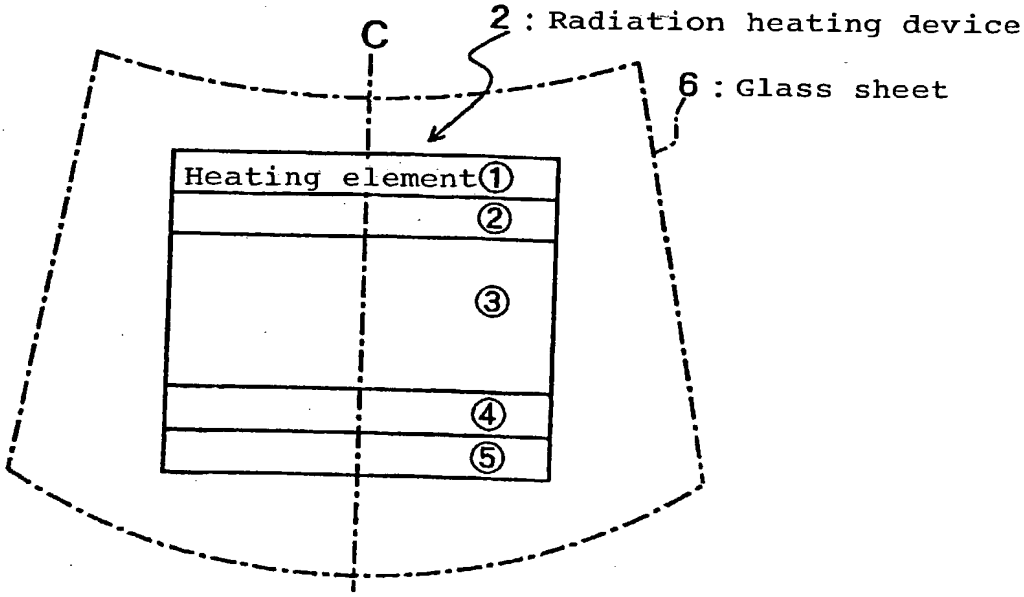

C
2 : Radiation heating device
6 : Glass sheet
Heating element ①
②
③
④
⑤

FIG. 4

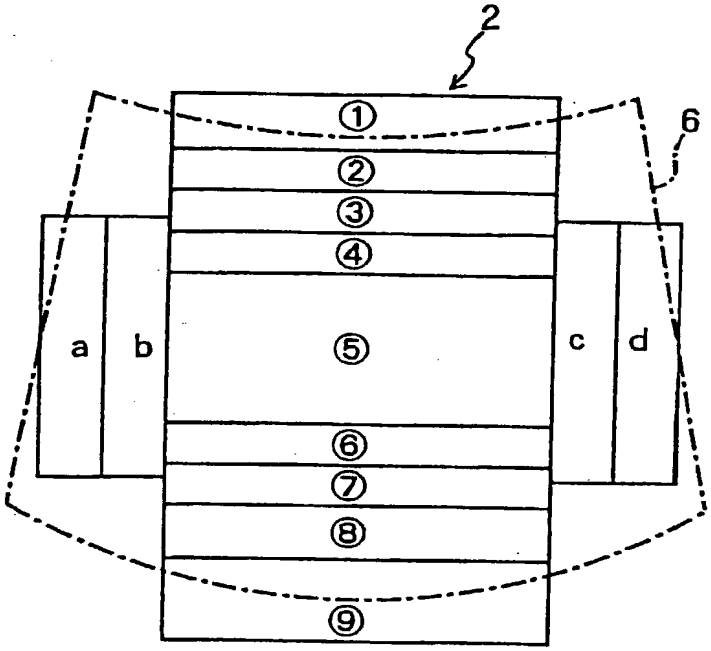


FIG. 5

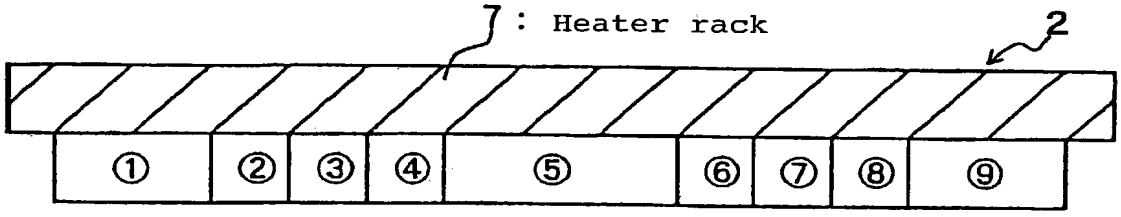


FIG. 6

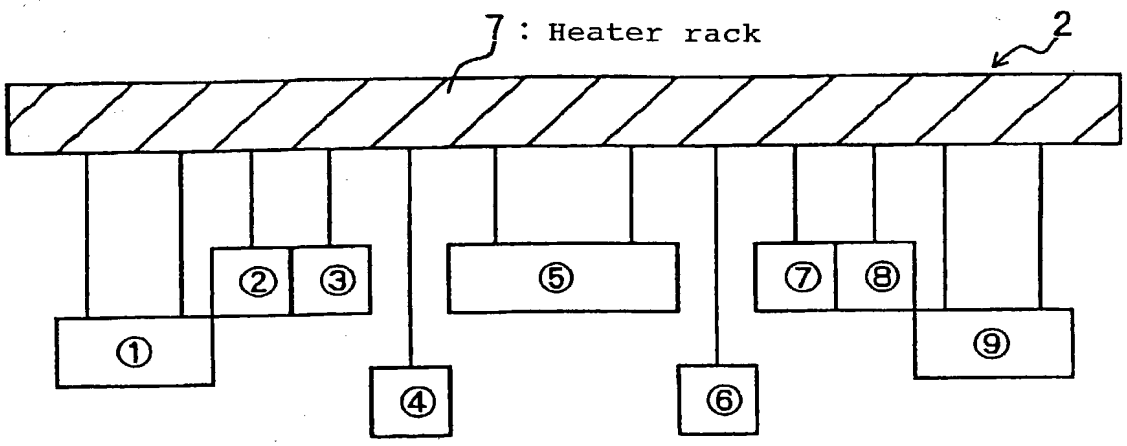

7 : Heater rack
2
①
②
③
④
⑤
⑥
⑦
⑧
⑨

FIG. 7

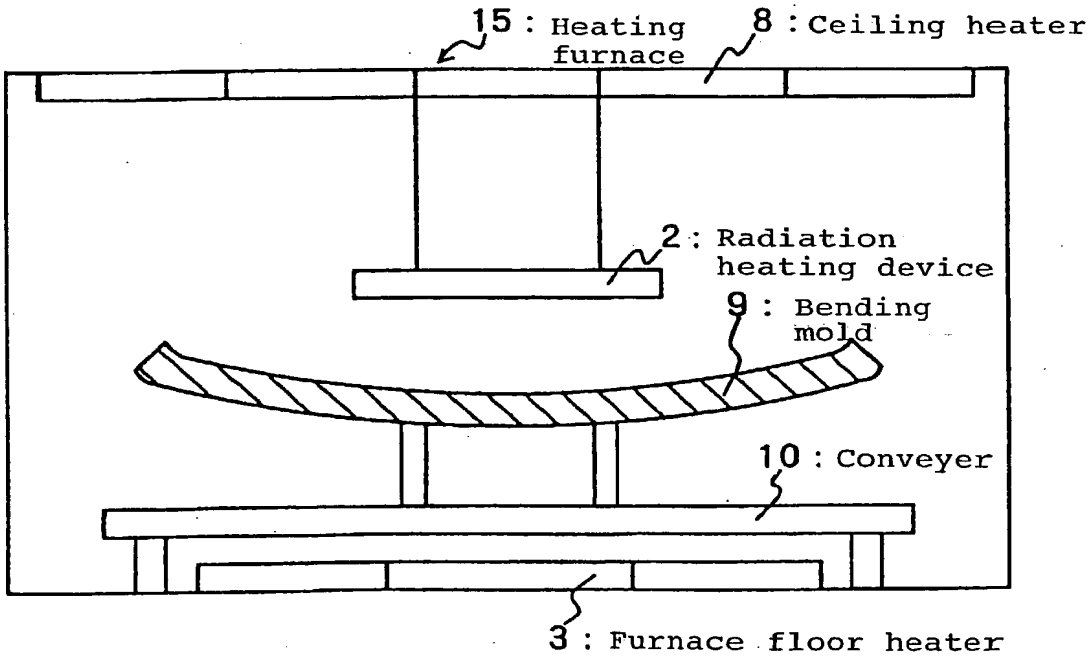

15 : Heating furnace
8 : Ceiling heater
2 : Radiation heating device
9 : Bending mold
10 : Conveyer
3 : Furnace floor heater

FIG. 8

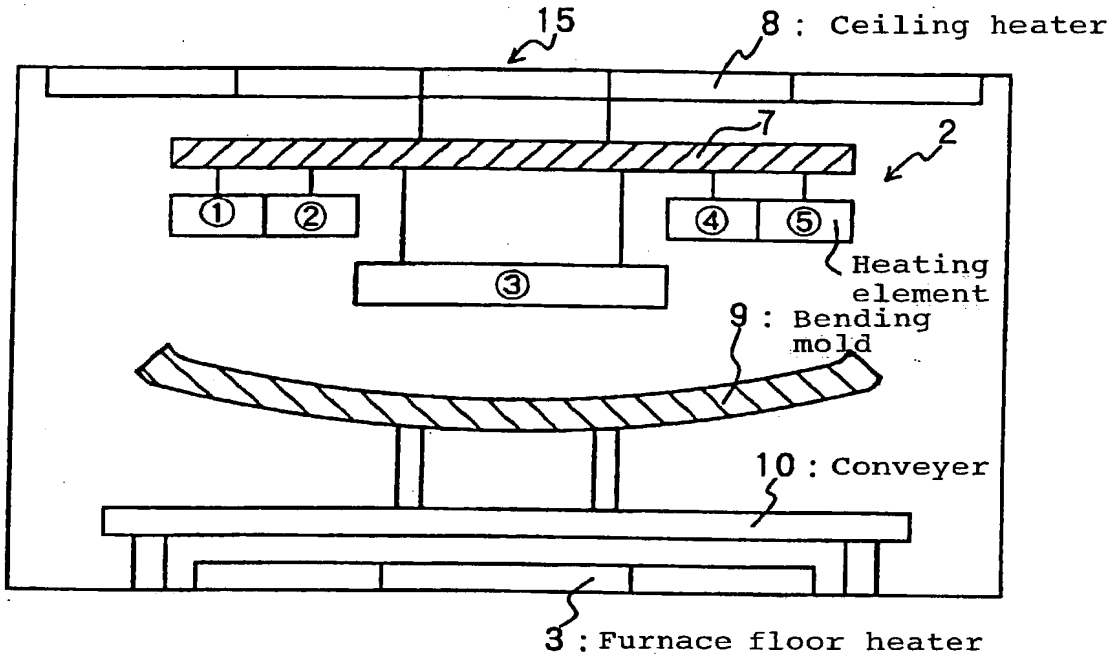
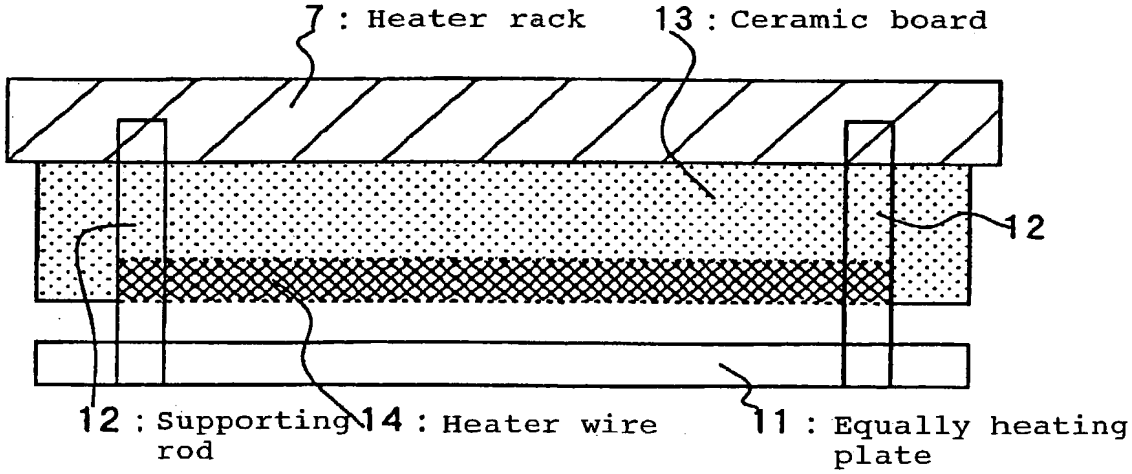

15
8 : Ceiling heater
7
2
①
②
④
⑤
③
Heating element
9 : Bending mold
10 : Conveyer
3 : Furnace floor heater

FIG. 9


7 : Heater rack
13 : Ceramic board
12
12 : Supporting rod
14 : Heater wire
11 : Equally heating plate

AB-230-US. PCT
(F2000-074)

Docket No. 208524US3PCT

Substitute
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特許出願宣言書及び委任状

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下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

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下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者（下記の名称が複数の場合）であると信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

BENDING APPARATUS FOR GLASS SHEET AND METHOD OF BENDING GLASS SHEET

上記発明の明細書は、

the specification of which

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☐ is attached hereto.

☐ _____ 月 _____ 日に提出され、米国出願番号または特許協定条約国際出願番号を

_____ とし、

（該当する場合） _____ に訂正されました。

☒ was filed on May 25, 2001

as United States Application Number or PCT International Application Number

09/831,913 and was amended on

_____ (if applicable)

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

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（弁護士、または代理人の指名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)

022850

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Direct Telephone calls to: (name and telephone number)

(703) 413-3000

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国籍	Citizenship Japanese
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第二の共同発明者の署名　日付	Second inventor's signature　Date
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国籍	Citizenship Japanese
郵便の宛先	Mailing Address Same as above

第三以降の共同発明者についても同様に記載し、署名すること）

(Supply similar information and signature for third and subsequent joint inventors.)

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発明者の署名　日付	Inventor's signature　Date ✓
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国籍	Citizenship Japanese
郵便の宛先	Mailing Address Same as above

第二の共同発明者の氏名　200	Full name of second joint inventor, If any Junji TANAKA
第二の共同発明者の署名　日付	Second inventor's signature　Date ✓ J. Tanaka　Apr. 22, 2002
住所	Residence c/o Asahi Glass Company, Limited, 426-1, Azakosawauehara, Sumida, Aikawa-machi, Aiko-gun, Kanagawa 243-0301, Japan JPX
国籍	Citizenship Japanese
郵便の宛先	Mailing Address Same as above

第三以降の共同発明者についても同様に記載し、署名すること）

(Supply similar information and signature for third and subsequent joint inventors.)

第三の共同発明者の氏名	300	Full name of third joint inventor, If any Toshimi YAJIMA
第三の共同発明者の署名	日付	Third inventor's signature Date T. Yajima Apr. 17, 2002
住所		Residence c/o Asahi Glass Company, Limited, 1, Aza-asahi, Taketoyo-cho, Chita-gun, Aichi 470-2514, Japan
住所		Citizenship Japanese JPY
郵便の宛先		Mailing Address Same as above

第四の共同発明者の氏名	400	Full name of fourth joint inventor, If any Masahiro TSUCHIYA
第四の共同発明者の署名	日付	Fourth inventor's signature Date M. Tsuchiya Apr. 15, 2002
住所		Residence c/o Asahi Glass Company, Limited, 1, Aza-asahi, Taketoyo-cho, Chita-gun, Aichi 470-2514, Japan
住所		Citizenship Japanese JPY
郵便の宛先		Mailing Address Same as above

第五の共同発明者の氏名	500	Full name of fifth joint inventor, If any Masaaki KONISHI
第五の共同発明者の署名	日付	Fifth inventor's signature Date M. Konishi Apr. 15, 2002
住所		Residence c/o Asahi Glass Company, Limited, 1150, Hazawa-cho, Kanagawa-ku, Yokohama-shi, Kanagawa 221-8755, Japan JPY
住所		Citizenship Japanese
郵便の宛先		Mailing Address Same as above

第六の共同発明者の氏名		Full name of sixth joint inventor, If any
第六の共同発明者の署名	日付	Sixth inventor's signature Date
住所		Residence
住所		Citizenship
郵便の宛先		Mailing Address

第七以降の共同発明者についても同様に記載し、署名すること)

(Supply similar information and signature for seventh and subsequent joint inventors.)

AB-230-US-PCT
(F2000-074)

Docket No. 208524US3PCT

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特許出願宣言書及び委任状

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the specification of which

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（該当する場合） _____ に訂正されました。

☒ was filed on May 25, 2001

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09/831,913 and was amended on

_____ (if applicable)

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I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

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(日本語宣言書)

私は、米国法典第35編119条(a) – (d)項又は365条 (b) 項に基づき下記の、米国以外の国の少なくとも一ヵ国を指定している特許協力条約365(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, § 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Claimed 優先権主張 Yes はい	No いいえ
11-272805	Japan	27 September 1999	☒	☐

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I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)

私は、下記の米国法典第35編120条に基づいて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条 (c) に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)
PCT/JP00/06518	September 22, 2000	
(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration
(日本語宣言書)

私は、米国法典第35編119条(a) – (d)項又は365条 (b) 項に基づき下記の、米国以外の国の少なくとも一ヵ国を指定している特許協力条約365(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, § 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Claimed 優先権主張 Yes はい	No いいえ
11-272805	Japan	27 September 1999	☒	☐

私は、第35編米国法典119条 (e) 項に基づいて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)

私は、下記の米国法典第35編120条に基づいて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条 (c) に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)
PCT/JP00/06518	September 22, 2000	

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

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第三の共同発明者の氏名	Full name of third joint inventor, If any Toshimi YAJIMA
第三の共同発明者の署名　日付	Third inventor's signature　Date
住所	Residence c/o Asahi Glass Company, Limited, 1, Aza-asahi, Taketoyo-cho, Chita-gun, Aichi 470-2514, Japan
住所	Citizenship Japanese
郵便の宛先	Mailing Address Same as above

第四の共同発明者の氏名	Full name of fourth joint inventor, If any Masahiro TSUCHIYA
第四の共同発明者の署名　日付	Fourth inventor's signature　Date
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第五の共同発明者の氏名	Full name of fifth joint inventor, If any Masaaki KONISHI
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住所	Citizenship Japanese
郵便の宛先	Mailing Address Same as above

第六の共同発明者の氏名	Full name of sixth joint inventor, If any
第六の共同発明者の署名　日付	Sixth inventor's signature　Date
住所	Residence
住所	Citizenship
郵便の宛先	Mailing Address

第七以降の共同発明者についても同様に記載し、署名すること）

(Supply similar information and signature for seventh and subsequent joint inventors.)